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# Immediate Water Pollution Control Needs Upper Red River Basin Texas and Oklahoma

Federal Water Pollution Control Administration, Dallas, Texas

Apr 67

PB 266 394

# IMMEDIATE WATER POLLUTION CONTROL NEEDS

# UPPER RED RIVER BASIN

# TEXAS AND OKLAHOMA

UNITED STATES
DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
SOUTH CENTRAL REGION
DALLAS, TEXAS 75202

APRIL 1967

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16. ABSTRACT

The purpose of the report is to focus attention on known sources of pollution in this area and to provide a priority for actionto correct existing problems and to prevent future problems

17. KEY WORDS AND DOCUMENT ANALYSIS

| a. DESCRIPTORS | b. IDENTIFIERS/OPEN ENDED TERMS | c. COSATI Field/Group |
|---|---|---|
| Water Pollution Control<br>Red River Basin<br>Texas<br>Oklahoma | | |

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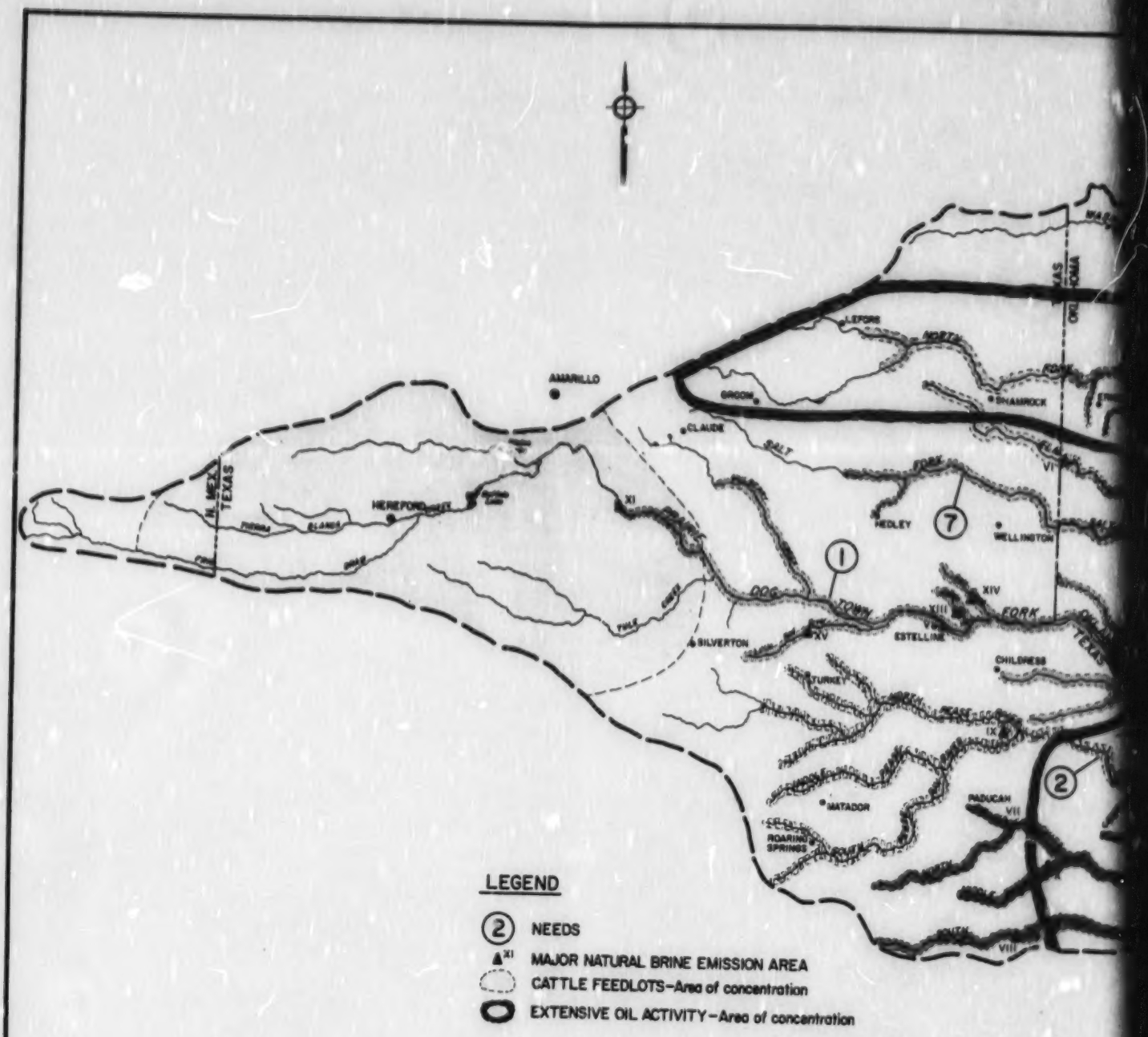
## I. Introduction

The purpose of this report is to focus attention on known sources of pollution and to provide a priority for action to correct the existing water pollution problems and prevent future problems in the Upper Red River, (see figure 1), an interstate stream and its tributaries. This report is based on compilations of available data of the Federal Water Pollution Control Administration, South Central Region, other Federal agencies, and the pollution control agencies of Texas and Oklahoma. No detailed water quality surveys or engineering studies were carried out for the preparation of this report.

The findings of this report are based on the best information available at this time on water quality conditions and immediate and potential pollution abatement needs. The omission of any particular town, industry, or other establishment from this report does not imply that an immediate or potential pollution abatement need may not exist in that particular area. Priorities listed are based solely on an evaluation of the Upper Red River basin and not on a relative basis with other basins in the South Central Region.

Authority is given in Section 3(a) of the Federal Water Pollution Control Act, as amended, for the preparation or development of comprehensive programs for eliminating or reducing the pollution of interstate waters and tributaries thereof and improving the sanitary conditions of surface and underground waters. This report, by describing the immediate needs for controlling water pollution in the Upper Red River basin, represents a further step in the development of a comprehensive program to control water pollution in this basin.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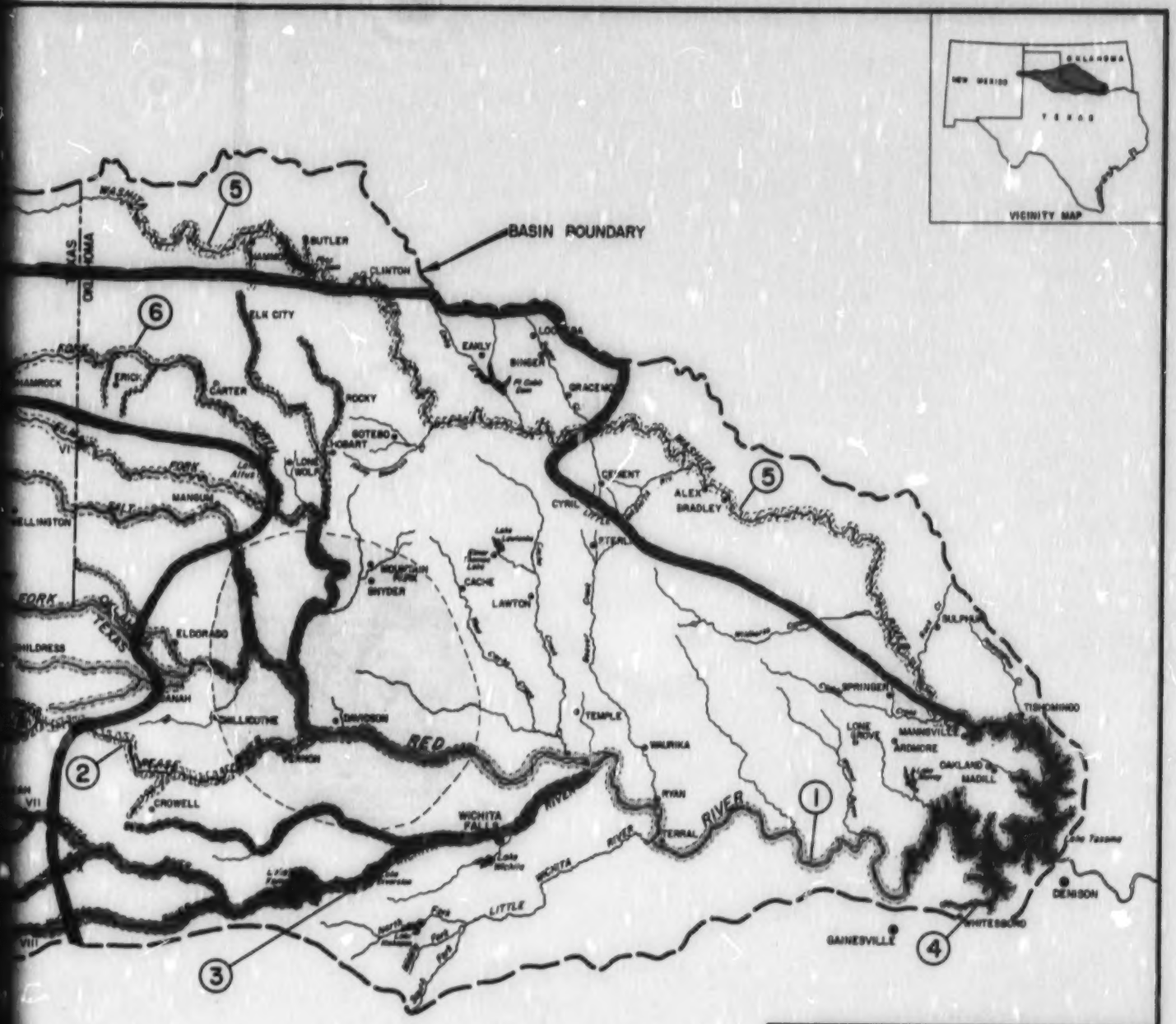
NEEDS
MAJOR NATURAL BRINE EMISSION AREA
CATTLE FEEDLOTS–Area of concentration
EXTENSIVE OIL ACTIVITY–Area of concentration




IMMEDIATE WATER POLLUTION CONTROL NEEDS
UPPER RED RIVER BASIN — TEXAS & OKLAHOMA

LOCATION MAP

UNITED STATES DEPARTMENT OF THE INTERIOR
Federal Water Pollution Control Administration
SOUTH CENTRAL REGION APR. 1967 DALLAS, TEXAS

FIGURE 1

## II. Summary of Immediate Pollution Control Needs

Pollution problems in the Upper Red River basin, as indicated by high concentration of salt in streamflow, septic conditions, oxygen depletion, and degradation of aesthetics, result in damages to municipal, industrial and agricultural water supply, fish and wildlife propogation, and recreational uses. The immediate pollution control needs are listed in the following tabulation and grouped into categories: natural salt pollution control, waste treatment, other pollution control practices, institutional practices and research. Location designations refer to figure 1.

| Location | Responsibility | Need | Priority |
|---|---|---|---|
| **Natural Salt Pollution Control** | | | |
| 1 - XI, XIII, XIV | Corps of Engineers | Subsurface collection systems with off-channel evaporation ponds | A |
| 2 - IX | Corps of Engineers | | |
| 6 - VI | Corps of Engineers | | |
| 1 - XV | Corps of Engineers | Complete impoundment in an evaporation pond | A |
| 3 - VII, VIII, X | Corps of Engineers | Low-flow dams and off-channel evaporation ponds | A |
| **Waste Treatment** | | | |
| 1 Prairie Dog Town Fork and Main Stem Red River: | | | |
| | Cities of: | | |
| | Silverton, Texas | Secondary treatment | B |
| | Estelline, Texas | Secondary treatment | B |
| | Childress, Texas | Secondary treatment | B |
| | Eldorado, Oklahoma | Primary & secondary treatment | B |
| | Quanah, Texas | Primary & secondary treatment | B |
| | Chillicothe, Texas | Secondary treatment | B |
| | Claude, Texas | Secondary treatment | B |
| | Davidson, Oklahoma | Primary & secondary treatment | B |
| | Cache, Oklahoma | Primary & secondary treatment | B |

| Location | Responsibility | Need | Priority |
|---|---|---|---|
| **Waste Treatment** (continued) | | | |
| | Cities of: | | |
| | Sterling, Oklahoma | Expansion of secondary treatment | B |
| | Lawton, Oklahoma | Expansion of secondary treatment | B |
| | Temple, Oklahoma | Primary & secondary treatment | B |
| | Waurika, Oklahoma | Primary & secondary treatment | B |
| | Ryan, Oklahoma | Primary & secondary treatment | B |
| | Terral, Oklahoma | Expansion of secondary treatment | B |
| | Lone Grove, Oklahoma | Primary & secondary treatment | B |
| | Corps of Engineers - Texoma Res.,Rec.Areas | Primary & secondary treatment | B |
| 2 **Pease River**: | | | |
| | Cities of: | | |
| | Turkey, Texas | Secondary treatment | B |
| | Matador, Texas | Secondary treatment | B |
| | Roaring Springs,Tex. | Secondary treatment | B |
| | Vernon, Texas | Primary & secondary treatment | B |
| 3 **Wichita River**: | | | |
| | Cities of: | | |
| | Paducah, Texas | Expansion of secondary treatment | B |
| | Crowell, Texas | Primary & secondary treatment | B |
| 4 **Mineral Creek**: | | | |
| | City of: | | |
| | Whitesboro, Texas | Primary & secondary treatment | B |

| Location | Responsibility | Need | Priority |
|---|---|---|---|
| **Waste Treatment** (continued) | | | |
| 5 **Washita River**: | | | |
| | Cities of: | | |
| | Hammon, Oklahoma | Primary & secondary treatment | B |
| | Butler, Oklahoma | Primary & secondary treatment | B |
| | Eakly, Oklahoma | Primary & secondary treatment | B |
| | Lookeba, Oklahoma | Primary & secondary treatment | B |
| | Binger, Oklahoma | Expansion of secondary treatment | B |
| | Gotebo, Oklahoma | Secondary treatment | B |
| | Gracemont, Oklahoma | Primary & secondary treatment | B |
| | Cyril, Oklahoma | Secondary treatment | B |
| | Cement, Oklahoma | Primary & secondary treatment | B |
| | Alex, Oklahoma | Secondary treatment | B |
| | Bradley, Oklahoma | Primary & secondary treatment | B |
| | Sulphur, Oklahoma | Expansion of secondary treatment | B |
| | Springer, Oklahoma | Primary & secondary treatment | B |
| | Ardmore, Oklahoma | Expansion of secondary treatment | B |
| | Ben Franklin Ref. | Expansion of lagoons | A |
| | Big Chief Roofing Co. | Skimming device & outfall sewer | A |
| | Oakland, Oklahoma | Primary & secondary treatment | B |
| | Madill, Oklahoma | Expansion of secondary treatment | B |
| | Hobart, Oklahoma | Expansion of secondary treatment | B |
| | Mannsville, Oklahoma | Primary & secondary treatment | B |
| | Tishomingo, Oklahoma | Primary & secondary treatment | B |

| Location | Responsibility | Need | Priority |
|---|---|---|---|
| **Waste Treatment** (continued) | | | |
| 6 **North Fork of Red River:** | | | |
| | Cities of: | | |
| | Groom, Texas | Secondary treatment | B |
| | Lefors, Texas | Secondary treatment | B |
| | Shamrock, Texas | Primary & secondary treatment | B |
| | Erick, Oklahoma | Expansion of secondary treatment | B |
| | Elk City, Oklahoma | Expansion of secondary treatment | B |
| | Carter, Oklahoma | Primary & secondary treatment | B |
| | Lone Wolf, Oklahoma | Secondary treatment | B |
| | Rocky, Oklahoma | Expansion of secondary treatment | B |
| | Mountain Park, Okla. | Primary & secondary treatment | B |
| | Snyder, Oklahoma | Primary & secondary treatment | B |
| 7 **Salt Fork of Red River:** | | | |
| | Cities of: | | |
| | Hedley, Texas | Secondary treatment | B |
| | Wellington, Texas | Primary & secondary treatment | B |
| | Mangum, Oklahoma | Expansion of secondary treatment | B |
| **Other Pollution Control Practices** | | | |
| Basinwide | States of Texas and Oklahoma | Continued rigid enforcement of laws on proper disposal of oil field brines & other wastes | A |
| 1 | States of Texas and Oklahoma & local interests | Construction of feedlot pollution control facilities | B |
| 5 | City of Clinton, Oklahoma | Injection of brines removed from water supply | B |

| Location | Responsibility | Need | Priority |
|---|---|---|---|
| **Institutional Practices** | | | |
| Basinwide | States of Texas and Oklahoma | Preparation and adoption of water quality standards on interstate & intrastate streams | A |
| Basinwide | States of Texas and Oklahoma | Legislation to provide appropriations for state participation in grants for construction of sewage treatment works | B |
| Basinwide | States of Texas and Oklahoma | Expand inspection program of water pollution control measures, operation and maintenance | A |
| Basinwide | State of Texas and Oklahoma | Preparation and maintenance of complete industrial waste discharge inventory for industries not connected with municipal treatment systems | B |
| Basinwide | States of Texas and Oklahoma | Legislation establishing controls over feedlot waste disposal | B |

| Location | Responsibility | Need | Priority |
|---|---|---|---|
| **Research** | | | |
| Basinwide | FWPCA and area Universities | Continue research to develop effective and economical method of treating feedlot pollution | B |
| Basinwide | Corps of Engineer and FWPCA | Continue study of measures to control salt and gypsum from natural sources | A |
| Basinwide | FWPCA, States of Oklahoma and Texas, oil industry | Additional study on pollution of ground water resulting from oil field brine disposal to determine means for control | A |

## III. Immediate Control Needs

Various measures are needed to control existing and potential water pollution of the Upper Red River and its tributaries. Measures to reduce the concentration of salt, to abate septic conditions, to increase oxygen content, and to reduce the concentration of nutrients are needed for the protection and expansion of water uses within the basin. These uses include municipal, industrial and agricultural supply, recreation, and fish and wildlife propagation.

The actions recommended here though not all encompassing are, however, prerequisite to good water quality planning and should be included in local, State, and Federal programming for water pollution control. Background for these immediate needs is summarized in Chapter VI.

### Natural Pollution Control

To substantially reduce the natural chloride load to the streams of the basin (the most crucial problem) the following control measures have been proposed:

| Location | Major Problem Area | Proposed Solution | Estimated Percent Chloride Load Reduction |
|---|---|---|---|
| 6 | Area VI - Elm Fork of the Red River | Subsurface collection system with off-channel evaporation pond | 80 |
| 2 | Area IX - North and Middle Pease Rivers | Subsurface collection system with off-channel evaporation pond | 70 |
| 1 | Area XIII and XIV - Jonah Creek and Salt Creek of Prairie Dog Town Fork of the Red River | Subsurface collection system with off-channel evaporation pond | 70 |
| 1 | Area XI - Prairie Dog Town Fork of the Red River | Subsurface collection system with off-channel evaporation pond | 50 |

| Location | Major Problem Area | Proposed Solution | Estimated Percent Chloride Load Reduction |
|---|---|---|---|
| 1 | Area XV - Little Red River | Complete impoundment in an evaporation pond downstream from source area | 90 |
| 3 | Area VII, VIII, and X - North, Middle, and South Forks of the Wichita River | Low flow dams and off-channel evaporation pond | 80 |

The effectiveness of the control measures would be limited to some degree by the existing chlorides absorbed and deposited in the banks, beds and floodplains of the streams.

An evaluation of the effectiveness of the control measures on reduction of sulfates has not been made to date. There will be some reduction, however, in areas where gypsum deposits are located upstream from the control structures. In most areas the gypsum deposits are interbedded with the salt formations.

Waste Treatment

New or expanded treatment facilities are needed by at least 55 communities, 1 Corps of Engineers reservoir project recreation area, and 2 industries (as listed in the summary table). The list of needs is not considered all inclusive and does not reflect projected needs due to future obsolesence or to expanded or changed water uses.

Most of the rivers and streams of the Upper Red River basin into which wastes are discharged have intermittent flow. High efficiency of operation of waste treatment plants and, in some instances, chlorination of effluent are necessary for bacteriological control. Because of the semiarid climate and the high unit cost of reservoir yield in this basin, it is not considered practical or economical to provide dilution flows.

Other Pollution Control Practices

Continued surveillance and enforcement action by the States of Texas and Oklahoma are needed to control stream pollution from oil field brines and other wastes from oil operations. Control

measures required include continued reinjection of brines, elimination of earthen pits, plugging of abandoned wells and construction of adequate refinery lagoons.

The city of Clinton, Oklahoma should inject brines that are removed from its water supply into subsurface strata.

Construction of waste control facilities for cattle feedlot runoff is needed to abate stream and groundwater pollution.

Institutional Practices

To strengthen the states' position on prevention, control and abatement of stream pollution, water quality standards are needed on both interstate and intrastate streams. State participation is needed in the waste treatment plant construction grants program to accelerate the construction of needed improvements. Increased surveillance and operation inspection of sewage and industrial waste treatment plants are needed to locate and identify existing or potential serious pollution problems. For more rigid control over industrial pollution and aid in solving complex stream quality problems, a complete and up-to-date inventory is needed of industrial waste discharges to basin streams, listing quantity and quality of effluent and other pertinent data.

Legislation with enforcement provisions is needed in the states of Texas and Oklahoma to establish control over waste disposal from cattle feedlots. The legislation should provide for a State administered program of permits, or licensing and inspection.

Research

An expanded research program by Federal Water Pollution Control Administration, universities in this region and others is needed to develop an economical and effective method for treatment of feedlot wastes. Further study is also needed by FWPCA, the states, and the oil industry to determine the extent of groundwater pollution as a result of oil field brine disposal.

Further planning and study by the Corps of Engineers and Federal Water Pollution Control Administration are needed to develop a feasible means of abating stream pollution from secondary salt and gypsum deposits in the Washita River basin, on the Salt Fork of the Red River, and on other tributary streams not affected by the major brine emission areas.

## IV. Costs

The estimated cost of pollution control measures listed in the summary table is shown in the following tabulation:

| Item | Estimated Cost * |
|---|---|
| **Natural Salt Pollution Control** | |
| Emission Area VI - Subsurface collection system with off-channel evaporation pond | 8,600,000 |
| Emission Area IX - Subsurface collection system with off-channel evaporation pond | 18,100,000 |
| Emission Areas XIII & XIV - Subsurface collection system with off-channel evaporation pond | 18,200,000 |
| Emission Area XI - Subsurface collection system with off-channel evaporation pond | 15,300,000 |
| Emission Area XV - Complete impoundment in an evaporation pond | 10,800,000 |
| Emission Areas VII, VIII, & X - Low flow dams and off-channel evaporation pond | 43,500,000 |
| Sub Total | $114,500,000 |
| Other natural salt and gypsum control measures (secondary areas) | Unknown |
| **Waste Treatment** | |
| Municipalities: | |
| New treatment facilities | 2,500,000 |
| Expansion of treatment facilities | 3,600,000 |
| Sub Total | 6,100,000 |
| Industries: | |
| New treatment facilities | 90,000 |
| Additional oil field operations and brine reinjection costs | Unknown |

| Item | | Estimated Cost * |
|---|---|---|
| Waste Treatment (continued) | | |
| Federal Reservoir - Recreation Areas: | | |
| New treatment facilities | | 10,000 |
| | Sub Total - Waste Treatment | 6,200,000 |
| Other Pollution Control | | |
| Injection well and appurtenant works (city of Clinton, Oklahoma) | | 100,000 |
| Feedlot retention structures | | 200,000 |
| | Sub Total | 300,000 |
| | TOTAL | $121,000,000 |

Of the total cost, approximately $114,000,000, exclusive of research costs, would be needed for control measures listed under priority "A" in the summary table.

* The cost estimates were based on January 1966 price levels.

## V. Recent Progress in Pollution Control

### State Programs

The following actions have been taken in recent years by the state agencies of Oklahoma and Texas to study, correct and prevent pollution in the Upper Red River basin:

1. An extensive program on oil field operations to eliminate brine and oil pollution including:

   a. Eliminating open brine and oil waste pits or sealing with impervious material.

   b. Deep well injection of brines.

   c. Plugging abandoned oil wells to prevent brine intrusion into fresh water aquifers, especially before waterflooding operations.

   d. Proper casing of operating wells.

   e. Surveillance and enforcement action on overall operation.

The effectiveness of this program is shown in the following tabulation and reduced chloride loadings on basin streams, though but a few have improved in quality sufficiently to be used for municipal and industrial water supply:

Oil Field Pollution Control Activities, 1960 - 1966

| State | Brine Storage Pits Eliminated | Reinjection and/or Disposal Wells | Enforcement Actions | Percent of Brine Reinjected |
|---|---|---|---|---|
| Oklahoma | 2,476 | 3,500 | 30 | 95.0 |
| Texas | 20,500* | 705 | 47 | 98.0 |

* Note: 40,000 brine storage pits in Texas were inventoried in 1963.

2. Applicator laws regulating, with enforcement, aerial spraying of pesticides and herbicides. (Since 1963, no fish kills in the basin have been attributed to pesticide spraying.)

3. Permits required for industrial and municipal waste discharges.

4. Policies requiring a minimum of secondary treatment for municipal wastes.

5. Certification of water and waste treatment plant operators.

6. Training programs for treatment plant operators.

7. Requirement of operation and maintenance reports on treatment plants.

8. General surveillance (including mobil laboratory facilities) and enforcement action.

9. Participation with municipalities in waste treatment plant construction.

Federal Construction Grants Program

Through a continuing construction grants program, treatment facilities and appurtenant works have been constructed at 28 towns and cities in the basin since 1957. Under this program 3 additional projects are under construction and grant offers have been made for facilities at 4 other cities.

Arkansas-Red River Basin Water Pollution Control Program

The Federal Water Pollution Control Administration has initiated in the Upper Red River basin an extensive stream monitoring and analysis program, in cooperation with the Geological Survey and other Federal and state agencies. Assistance has been provided by the Federal Water Pollution Control Administration to other agencies including personnel training and laboratory analysis service.

Arkansas-Red River Basins Water Quality Conservation Study

The Division of Water Supply and Pollution Control, Public Health Service (now FWPCA) completed a basic study in 1964 on water quality, sources of natural and manmade salt pollution, and suggested corrective measures for the Arkansas-Red River basins. The study area included the Upper Red River basin.

Survey Report on Arkansas-Red River Basin, Water Quality Control Study

The U. S. Army Engineer District, Tulsa, Corps of Engineers, has completed a survey report in 2 parts on water quality control in an area encompassing the Upper River basin. Subsequent to authorization of Part I of the project, 2 experimental salt emission control structures (Areas V & VIII) have been constructed and $1 million (of a total contingent appropriation of $46 million) has been appropriated for experimental projects in emission Areas I (Arkansas River basin) and VI (Elm Fork of the Upper Red River). The two experimental projects constructed (Areas V & VIII) have involved a principle of applying a hydrostatic backhead to suppress the brine flow from salt springs. The project at source VII on the South Fork of the Wichita River has been abandoned after proving unsatisfactory. The other project, located in the flood plain of the Prairie Dog Town Fork of the Red River at source V near Estelline, Texas, is currently in operation as chloride control project, and has so far been effective in eliminating about 375 tons of salt per day from entering the river and reducing the chlorides concentration of Red River, though not enough to permit widespread municipal and industrial water supply use.

University Programs

Texas Technological College, the University of Kansas and Kansas State University have initiated research programs on water pollution as related primarily to the runoff from cattle feedlots. The research at Texas Technological College is being conducted with support by the Feeder Cattle Division of the Texas and Southwestern Cattle Raisers Association.

## VI. Background

### Pertinent Basin Characteristics

The Upper Red River basin, as shown in figure 1, extends from the eastern part of New Mexico, through the Texas Panhandle, to Denison Dam on the divide between Texas and Oklahoma. The Red River forms the boundary between these two States along a 300-mile reach upstream from Lake Texoma. The Upper Red River and its tributaries drain an area of about 39,700 square miles of the high plains. The western portion of the basin is semiarid, and streamflows are generally intermittent. Rainfall at Lake Texoma (Denison Dam) averages 37 inches per year, and it decreases westward to less than 20 inches per year in the headwaters area. High evaporation and absorption minimizes runoff in the upper basin area. Increased rainfall and runoff below the Little Wichita River result in streamflows which increase downstream. The average flow of Red River into Lake Texoma for the 36 year period-of-record is approximately 4 million acre-feet per year.

Texoma Reservoir, the largest reservoir in the Upper Red River basin, is a Federal project constructed by the Corps of Engineers for flood control, hydroelectric power, water supply, and recreation. It has a total storage capacity of 5,553,000 acre-feet and a surface area of 91,200 acres (at top of power pool).

The total population of the basin is about 1 million, with approximately half residing in Texas and half in Oklahoma. The basin has an average population density of about 25 per square mile. The largest cities are Ardmore (21,000), Oklahoma, Wichita Falls (102,000), and Vernon (12,000), Texas.

Wheat production by dry land farming and livestock raising are principal economic activities in the Texas Panhandle. Ground water irrigation and extensive oil industry operations are most prevalent in the middle and eastern portions of the basin.

### Water Quality

The chemical quality of the surface waters of the Upper Red River basin is generally poor because of its high salt content. The water in most areas is also hard and generally turbid, particularly in the main stem of the Red River. Color in the main stem, except during low flow, is a reddish-brown, reflecting its high sediment load of sand and clay. The following tabulation shows average quality data on some principal streams and in major impoundments of the basin.

| | Dissolved Solids (mg/l) | Sulfates (mg/l) | Chlorides (mg/l) | Carbonate Hardness (mg/l) |
|---|---|---|---|---|
| Texoma Reservoir | 1,420 | 320 | 532 | 484 |
| Foss Reservoir | 1,450 | 830 | 34 | 930 |
| Kemp Reservoir* | 2,500 | 600 | 900 | - |
| Red River near Gainesville, Texas | 2,300 | 475 | 922 | 695 |
| Salt Fork near Elmer, Oklahoma | 2,520 | 1,030 | 540 | 1,180 |
| North Fork near Headrick, Oklahoma | 4,610 | 916 | 1,820 | 1,150 |
| Elm Fork near Mangum, Oklahoma | 15,600 | 1,980 | 7,300 | 2,570 |
| Washita River at Carnegie, Oklahoma | 1,540 | 824 | 90 | 938 |

*Estimated

Source: U.S. Geological Survey

Water resources of the basin are used for municipal and industrial water supply; agricultural water supply, including domestic; irrigation and livestock watering; fish and wildlife propagation; recreational activities; hydroelectric power production; industrial cooling operations, and for final disposal of waste treatment plant effluents. Extensive water quality problems have seriously damaged water use.

## Present Water Quality Problems

Because of widespread and extensive pollution, principally from natural salt, the surface water resources of the Upper Red River basin are, for the most part, inferior in quality and unsuitable for most municipal, industrial, and agricultural water supply purposes. Pollution problems have resulted in a critical shortage of high quality water in this semiarid area.

## Natural Pollution

Natural pollution is the most extensive and serious pollution problem in the Upper Red River basin. Natural brine (NaCl), gypsum ($CaSO_4$), and other soluble mineral deposits have degraded over 400

miles of main stem, and 500 miles of tributary streams, and all major reservoirs in the upper basin. Nine major sources of natural brine, listed in the following table and shown on figure 1, contribute about 2,000 tons per day of chlorides to these streams, representing from 40 to 50 percent of the total salt load in the river and in Texoma Reservoir. The combined flow of these emissions, however, represents less than 1 percent of the average total streamflow of the basin.

Gypsum deposits cause a high concentration of sulfates in about 400 miles of main stem and tributary streams in the upper basin. These gypsum deposits are widespread and frequently interbedded with salt deposits.

In addition to having high concentrations of chlorides and sulfates, the surface water resources of the basin are generally hard due to a high calcium and magnesium carbonate content.

As evidenced by the use spectrum shown in the following tabulation, the presence of natural mineral pollution in the rivers and reservoirs, particularly the high concentration of chlorides, is suppressing the water use in the Upper Red River basin. This limits industrial growth and, largely due to a reduction in crop yields and the ability to raise high value-low salt tolerant crops, reduces farm income.

## MAJOR NATURAL SOURCES OF BRINE

| Map Area No. | Salt Source Area | Identifying Community | Description Type Emission, Extent, Size | Approximate Concentration of Brine as Cl (mg/l) | Chloride Load Tons/Day Average | Estimated Concentrated Brine Flow (cfs) |
|---|---|---|---|---|---|---|
| VI | Elm Fork, Oklahoma | Carl, Okla. | Numerous seeps and small springs near mouths of three canyon streams (tributaries to Elm Fork of Red River) about 1 mile apart. | 190,000 | 250 | 1 |
| VII | North Fork, Wichita River, Texas | Paducah, Tex. | Several large springs, numerous seeps and salt plains, mostly on 2-mile stretch above mouth of Salt Creek of North Wichita River. | 20,000 | 200 | 2 |
| VIII | South Fork, Wichita River, Texas | Guthrie, Texas | Several large springs and numerous seeps along 2-mile stretch on South Wichita River. | 4,000-27,000 | 200 | 2 |
| IX | Middle and North Fork, Pease River, Texas | Childress, Tex. | Numerous seeps along 2-mile stretches of both North Pease and Middle Pease Rivers. | 10,000-20,000 | 350 | 2 |
| X | Middle Fork, Wichita River, Texas | Paducah, Texas | One large spring and several small seeps along 2-mile stretch of Middle Wichita River. | 2,000-4,000 | 50 | 1 |
| XI | Prairie Dog Town Fork, Texas | Brice, Texas | Numerous brine seep areas along Prairie Dog Town Fork of Red River, mostly at mouths of tributary streams. | 4,000-32,000 | 175 | 2 |
| XIII | Jonah Creek, Texas | Childress, Tex. | Salt plains, one large and numerous small brine springs in stream bed along edge of Jonah Creek for a 3-mile stretch above mouth. | 27,000-40,000 | 450 | 4 |
| XIV | Salt Creek, Texas | Childress, Tex. | Numerous small seeps in stream bed along 2-mile stretch above mouth. | 30,000 | 150 | 2 |
| XV | Little Red River, Texas | Turkey, Texas | Numerous small seeps & springs in stream bed at upper end of Little Red River for about 1-mile stretch of both North & South branches. | 100,000-150,000 | 150 | 1 |

CONCENTRATION - USE SPECTRUM

| Use | Dissolved Solids (mg/l) | Sulfates (mg/l) | Chlorides (mg/l) | Carbonate Hardness (mg/l) |
|---|---|---|---|---|
| Stock and wildlife | 2500 | 100 | 1500 | - |
| Food canning and freezing | 850 | 20-60 | 760 | 100 |
| Domestic water supply | 500 | 250 | 250 | 100 |
| Carbonated beverages | 850 | 250 | 250 | 200 |
| Food equipment washing | 850 | - | 250 | 10 |
| Irrigation | 700-2000 | 200 | 250 | - |
| Steel making | - | - | 175 | 50 |
| Textile process | 100 | 100 | 100 | 50 |
| Brewing | 500 | - | 80 | - |
| Paper manufacturing, Kraft pulp | 300 | - | 200 | 100 |
| Paper manufacturing, soda pulp | 250 | - | 75 | 100 |
| Paper manufacturing, ground wood pulp | 500 | - | 75 | 200 |
| Electric steam generating plants | 75 | 100 | 2 | 2 |

Industrial Pollution

Extensive oil producing operations are located in the Upper Red River basin (see figure 1). There are approximately 160 oilfields, and 7 refineries within a 25-county area. An undetermined quantity of brine and oil waste is being discharged to streams of the basin, as determined through recent surveillance by the Federal Water Pollution Control Administration and the Geological Survey. Most of the pollution occurs as the result of waterflooding operations, line breaks, spills from open brine pits, operation accidents, and leaching of brines from soils in the oilfield areas. Some brine pollution of fresh ground water strata and surface water is resulting from waterflooding operations in areas where previously unknown and abandoned wells have not been properly plugged.

Stream pollution by two industries in Ardmore, Oklahoma has been reported by the Oklahoma Water Resources Board. The Big Chief Roofing Company, which reprocesses waste paper, is discharging organic wastes to Sand Creek without treatment, causing oxygen depletion in the stream and septic conditions. The Ben Franklin Refinery is discharging chlorides, phenols, and other oil wastes into Sand Creek, adding to the septic condition and detriment of aesthetics. The refinery's lagoon facility is inadequate and is subject to overflow and flooding.

Municipal Pollution

Throughout the Upper Red River basin, there are many smaller problems of water pollution in streams receiving waste discharges from communities having inadequate treatment facilities. The communities are tabulated in the summary table. Some receiving streams have a high nitrate content which has been attributed to municipal sewage. Intermittent flow of most streams in the basin contributes to the health hazard and aesthetics problem.

The city of Clinton, Oklahoma has received a demonstration grant for construction of electrodialysis facilities for removal of salts from its water supply (Foss Reservoir). Return of brine flows to the Washita River increases the solids content of this stream.

Agricultural Pollution

Extensive cattle feedlot operations are centered in 2 areas of the Upper Red River basin (see figure 1), with the largest concentration near Hereford, Texas. There are approximately 50 feedlots with feeding capacities in excess of 1,000 head of cattle. Total capacity of these lots is about 200,000 head of cattle. During periods of intensive rainfall and high runoff, waste discharges from these feedlots cause "slug" loading of streams and create septic conditions and degrade aesthetics. Nutrient ($NO_3$) buildup in ground water and reservoirs has been attributed to this source.

Turbidity

The soils of the Upper Red River basin are largely sand and clay. Because of the semiarid climate of the area, the vegetal cover is generally sparce, except in farming areas. Stream banks and flood plains are mostly barren because of the presence of salt. As a result, erosion during heavy rainfall periods causes a high sediment concentration in streamflow and reservoirs. The muddy condition of the rivers damages use of the streams for recreation and for fish and wildlife propagation, and is detrimental to aesthetics.

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